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Shock and Thermal History of Iron and Chondritic Meteorites

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This research grant included a study of the shock and thermal history of iron and chondritic meteorites. The important research findings are to be found in the 20 publications that were published as a result of the research support. A complete bibliographic reference to all these papers is given below. Attached to this report are copies of all reprints of the articles and all yearly progress reports for the grant.

Published Papers:

1. "The Wavelength-Dispersive Spectrometer and its Proposed Use in the Analytical Electron Microscope," Joseph I. Goldstein, Charles E. Lyman, and David B. Williams, Aussois Session II4, X-ray Detectors, C.E. Lyman, Chairman, Aussois, France, 1988, Ultramicroscopy, Vol. 28 North-Holland, Amsterdam, 162-164 (1989).
2. "Current Problems in X-ray Emission Spectroscopy," Joseph I. Goldstein, David B. Williams, and Charles E. Lyman, Aussois Session I3, Problems in X-ray Emission Spectroscopy, Aussois, France, 1988, Ultramicroscopy, Vol. 28 North-Holland, Amsterdam, 56-60 (1989).
3. "X-ray Detectors and Spectrometers," C. E. Lyman, D. B. Williams, and J. I. Goldstein, Ultramicroscopy, Vol. 28, North-Holland, Amsterdam, 137-139 (1989).
4. "Determination of the Fe-Ni Phase Diagram Below 400°," K. B. Reuter, D. B. Williams, and J. I. Goldstein, Met Trans A, Vol. 20A, 719-725 (April 1989).
5. "Ordering in the Fe-Ni and Fe-Ni-P Systems Under Electron Irradiation," K. B. Reuter, D. B. Williams, and J. I. Goldstein, Met. Trans. A, Vol. 20A, 711-718 (1989).
6. "Effect of Foil Thickness on Quantification of EDS Spectra," by J. I. Goldstein and D. B. Williams, 1989 MAS Proceedings, Asheville, N.C., Microbeam Analysis, ed. P. E. Russell, San Francisco Press, Inc., 501-506 (1989).
7. "The Hole Count Test Revisited-Effects of Test Specimen Thickness," C. E. Lyman, D. W. Ackland, D. B. Williams, and J. I. Goldstein, 199 MAS Proceedings, Asheville, N.C., Microbeam Analysis, ed. P. E. Russell, San Francisco Press, Inc., 507-510 (1989).
8. "Invar Alloys: Information from the Study of Iron Meteorites," J. I. Goldstein, D. B. Williams, J. Zhang, and R. Clarke, Physical Metallurgy of Controlled Expansion Invar-Type Alloys, edited by K. C. Russell and D. F. Smith, The Minerals, Metals & Materials Society, 67-83 (1990).
9. "Electron Microscopy Study of the Iron Meteorite Santa Catharina", J. Zhang, D. B. Williams, J. I. Goldstein and R. S. Clarke, Jr., Meteoritics, 25 (1990), p. 167.
10. "Spatial Resolution and Detectability Limits in Thin-Film X-ray Microanalysis", J. I. Goldstein, C. E. Lyman and J. Zhang, in Microbeam Analysis-1990, J. R. Michael and P. Ingram, Eds., San Francisco Press, Inc., (1990), p. 265.
11. "Practical Importance of Spatial Resolution and Analytical Sensitivity in AEM X-ray Microanalysis", J. Zhang, D. B. Williams and J. I. Goldstein, in Microbeam

Analysis-1990, J. R. Michael and P. Ingram, Eds., San Francisco Press, Inc., (1990), p. 307.

12. "The Structure and Composition of Metal Particles in Two Type 6 Ordinary Chondrites", C. E. Holland-Duffield, D. B. Williams and J. I. Goldstein, *Meteoritics* 26, 97-103, 1991.

13. "Thin-Film X-ray Quantitation: New Insights with the Aid of Monte Carlo Calculations", J. R. Michael, A. D. Romig, Jr. and J. I. Goldstein, Proc. of the 49th Annual Meeting of the Electron Microscopy Society of America, San Francisco Press, Inc., San Francisco, 718-719, 1991.

14. "The Spatial Resolution of X-ray Microanalysis in Thin Foils", D. B. Williams, J. R. Michael, J. I. Goldstein, and A. D. Romig, Jr, Proc. of the 49th Annual Meeting of the Electron Microscopy Society of America, San Francisco Press, Inc., San Francisco, 472-473, 1991.

15. "Quantitative X-ray Microanalysis in the Analytical Electron Microscope", D. B. Williams and J. I. Goldstein, In *Electron Probe Quantitation*, ed. K. F. J. Heinrich and D. E. Newbury, Plenum Press, 371-398, 1991.

16. "An APFIM/AEM Study of Phase Decomposition in Fe-Ni Alloys at Low Temperatures", J. Zhang, M. K. Miller, D. B. Williams and J. I. Goldstein, *Surface Science*, 266, 433-440, (1992).

17. "Definition of the Spatial Resolution of X-ray Microanalysis in Thin Foils", D. B. Williams, J. R. Michael, J. I. Goldstein and A. D. Romig, Jr., *Ultramicroscopy*, 47,121-132, (1992).

18. "X-ray Microanalysis and Electron Energy Loss Spectrometry in the Analytical Electron Microscope: Review and Future Directions", J. I. Goldstein and D. B. Williams, *Microbeam Analysis*, 1, 29-53, (1992).

19. "Future Directions of X-ray Microanalysis in the Analytical Microscope", J. I. Goldstein, in *Electron Microscopy I*, ed K. H. Kuo and Z. H. Zhai, 5th Asia-Pacific Electron Microscopy Conference, World Scientific, 138-141, (1992).

20. "Applications of the Analytical Electron Microscope to Materials Science", J. I. Goldstein, in *Micromat-92*, Sociedade Brasileira de Microscopia Electronica, 1-4, (1992).

Interim Reports of Grant NAG 9 - 45, dated 3/29/90, 3/28/91, 3/30/92 and 4/14/93 are attached to this Final Report.